RESULTS OF FIELD SURVEYS FOR BATS ON THE KOOTENAI NATIONAL FOREST AND THE LOLO NATIONAL FOREST OF WESTERN MONTANA, 1993

by

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SUMMARY

This report documents the findings of field investigations into the relative abundance and distribution of bats on the Kootenai National Forest and parts of the Lolo National Forest of western Montana from May 15 to September 28, 1993.

Two primary methods of investigating species composition and abundance were used. Bat echolcation calls were monitored along selected transect routes begining at sunset to record the relative abundance and activity patterns of bats. Mist nets were deployed across creeks, roads, trails, and adits to capture bats, providing the most reliable means for documenting species presence, and providing information on age, sex, and reproductive status.

A total of 123 bats representing eight species were captured in the study area. Bats of the genus *Myotis* accounted for 91 percent of all captures. *M. lucifugus* was captured most frequently (48%), followed by *M. californicus* (15%), *M. evotis* (13%), *M. volans* (8%), *Lasionyctereris noctivigans* (7%) and *M. ciliolabrum* (7%). One specimen each of *Plecotus townsendii* and *Lasiurus cinereus* were captured, comprising less than one percent of the total capture.

Relative bat abundance varied greatly between 24 sites monitored during the study. High levels of bat activity were found at Camp 32 (74 passes/hr.), Upper Fortine Creek (72 passes/hr.), and Trout Creek (60 passes/hr.). Sites demonstrating the most foraging activity as measured by feeding buzzes per hour were Camp 32 (n=29), Big Creek (n=14) and Bull Lake (n=13). The mean index of bat activity at the 24 transect locations was 33.5 ± 8.9 passes per hour, and 6.3 ± 2.7 feeding buzzes per hour (α=0.025).

Bats were regularly encountered foraging over roads, creeks, and ponds in the study area. Of 1,031 bat passes detected at 24 transect locations, 19 percent (n=196) were attempting to capture prey. Foraging activity was highest at Camp 32 where 43 percent of bats passes contained a feeding buzz. Foraging bats were absent at three sites in the study area, but comprised at least 8 percent of all bat passes at every other site.

Two adits investigated during this study are utilized by bats as night roosts. *Myotis evotis* were captured at the entrances of two adits on the Superior Ranger District. The Trout Creek adits, located on the west side of Trout Creek at approximately 3800' and 4100' elevation, were visited by male and female *M. evotis* on 13 July. The lower adit contained bat guano and culled moth wings.

Only three juvenile bats (2%) were captured during the study - two male *M. lucifugus* at Lower Fortine Creek on 29 August, and one female *M. volans* at Rock Creek on 27 September. Females comprised

62 of 120 adults captured in mist nets (52%). Lactating *M. lucifugus*, *M. californicus*, *M. ciliolabrum*, and *M. evotis* were captured during the study between 15 July and 1 September. Lactating females represented 7 percent of the total bats captured, and 13 percent of adult female bats captured. During the study, 24 percent of adult female bats captured were classified as either lactating (n=8), gravid (n=6), or postpartum (n=1). The observed low fecundity is likely due to the cold and wet weather experienced during the study.

Information needs for the effective management of bat populations include knowledge of distribution, population status, and habitat requirements. Echolocation monitoring and mist-netting can provide much-needed information that is the first step towards protecting bat habitat.

INTRODUCTION

Little is known regarding the distribution and abundance of bats in the forests of northwestern Montana. Nine species have been recorded in northwestern Montana (northwest of 47° latitude and 114° longitude) (Thompson 1982)[1] including the western big-eared bat (*Plecotus townsendii*) which is listed as a species of special concern by the Montana Natural Heritage Program (Genter 1993) and Montana Department of Fish, Wildlife, and Parks (Flath 1984). *P. townsendii* is also pending candidate status (C2) for possible protection under the Endangered Species Act, and a sensitive species for Regions 1, 3, and 4 of the USDA Forest Service (Finch 1992).

Bats may be sensitive to environmental modifications such as even age stand management, changes in the age-structure of forests, and changes in snag abundance (Thomas and West 1989). In order to assess the potential adverse effects of current and future land management practices on bat populations, a general survey of bat populations is needed. The scope of this study is to collect information on species composition, relative abundance, and activity patterns found in the forests of northwestern Montana. It is hoped that this study will provide land managers with reliable information with which to conduct future bat monitoring, and better assess the effects of land management activities.

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[1] *Myotis californicus, M. ciliolabrum, M. lucifugus, M. yumamensis, M. volans, M. evotis, Plecotus townsendii, Lasionycteris noctivigans, and Eptesicus fuscus.*

STUDY AREA

Bat surveys were conducted primarily on the Kootenai National Forest in northwestern Montana (Figure 1). Some surveys were conducted on the Superior Ranger District of the Lolo National Forest. The entire study area is contained within the northwestern forest region of Montana. The northwestern forest region differs from forests in the rest of Montana in its abundance of Pacific Coast species such as western redcedar (*Phuja plicata*), grand fir (*Abies grandis*), and western hemlock (*Tsuga heterophylla*) (Arno 1979). Moisture brought by maritime airmasses creates a generally mild and wet climate that favors the growth of these species (Arno 1979).

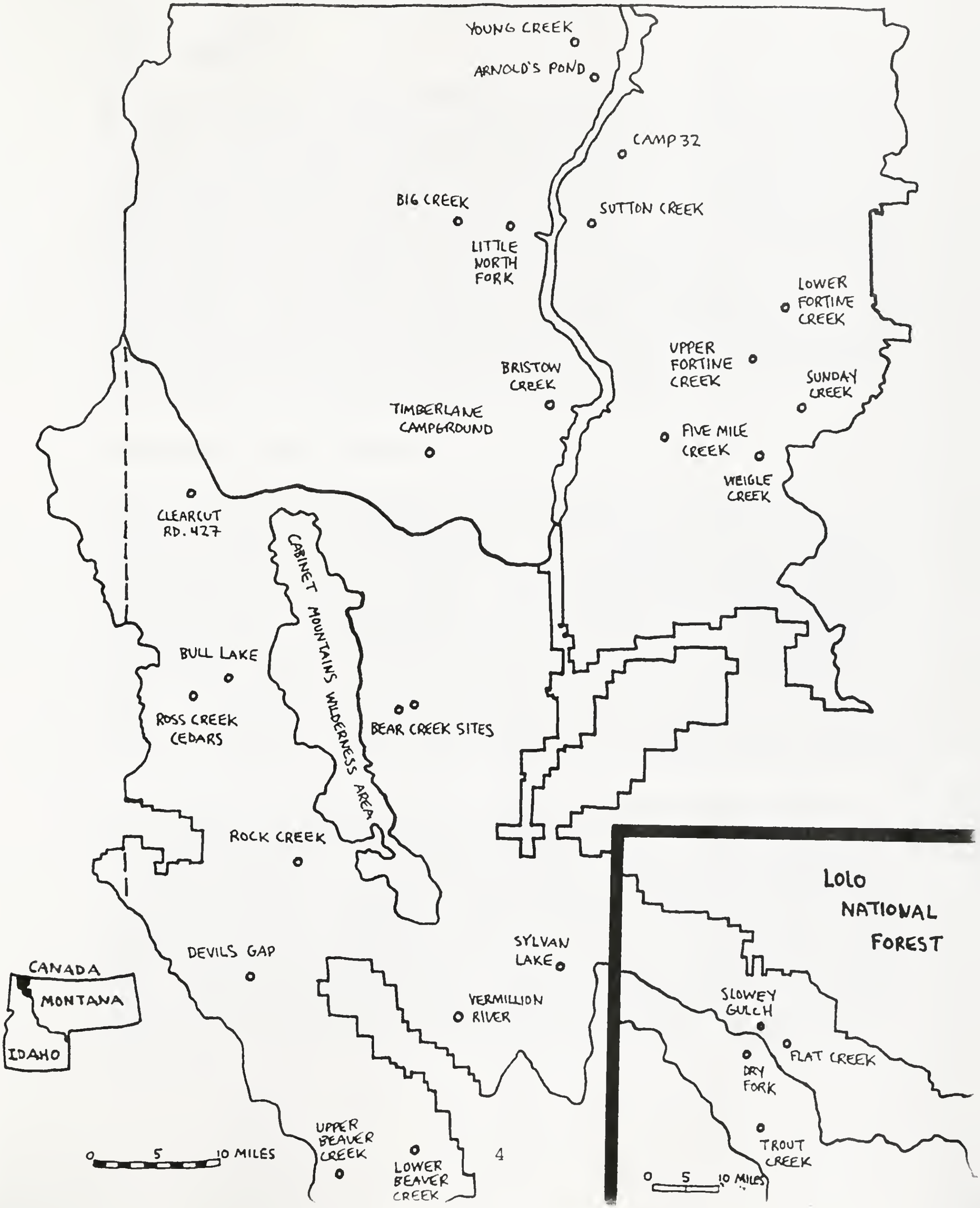
Weather conditions in the study area were unusually cold and wet during portions of the summer. Climatological data from the Libby Ranger Station (elevation 2,096') is indicative of the general conditions experienced in the study area (Table 1).

Table 1.-- Climatological data for Libby Ranger Station, May-September 1993.

	Precipitation	Average	Difference	Mean Temperature	Average	Difference
May	0.53 in	1.50 in	-0.97 in	60.4°	53.7°	+6.7°
Jun	1.79 in	1.55 in	+0.24 in	61.2°	60.7°	+0.5°
Jul	4.06 in	0.79 in	+3.27 in	61.5°	66.7°	-5.2°
Aug	1.02 in	1.07 in	-0.50 in	64.6°	65.4°	-0.8°
Sep	1.31 in	1.19 in	+0.12 in	57.6°	56.8°	+0.8°

Source: National Climatic Data Center, U.S. Department of Commerce. Asheville, NC.

Figure 1. -- Map of the Study Area: Kootenai National Forest.



METHODS AND MATERIALS

Capture methods

Mist nets were set across creeks, roads, trails, forest clearings, and mine entrances. Nets of 6 m, 9 m, and 13 m length with black or brown filament were deployed before sunset, and in most cases left open until sunrise the following morning. Captured bats were identified to species and sex. Forearm length was measured to the nearest one-tenth mm with calipers. Body mass was determined by weighing bats in a plastic bag of known mass with a calibrated 50-gram Pesola scale. Bats were categorized as adult or juvenile by examination of the degree of epiphyseal - diaphyseal fusion, and tooth wear (Anthony 1988). Bats were considered adult if epiphyseal - diaphyseal fusion was complete. Reproductive condition was assessed in female bats by palpation of the lower abdomen to determine pregnancy (Racey 1988) and nipple morphology and condition to identify lactating individuals.

Echolocation survey methods

Bat activity in the study area was monitored along selected transect routes using a hand-held Skye monitor or QMC Mini Bat Detector. Transects began shortly after sunset and continued, as conditions allowed, for at least 30 minutes following the first audible bat call of the evening. Echolocation calls were tuned to the lowest detectable frequency, and categorized as bat passes or feeding buzzes. The Skye monitor and the QMC Mini Bat Detector are tunable monitors sensitive to echolocation calls produced by bats common to Montana. The monitors function by generating an audible signal that is characteristic of the received ultrasonic signal. The Skye monitor and the QMC Mini permit easy characterization of bat calls as passes or feeding buzzes, and can be used to quantify general bat activity in a given habitat.

Both monitors are sensitive to a small frequency range at any given setting, preventing the operator from scanning all frequencies at one time (Thomas and West 1984). This limitation precludes identification of all bat calls to species within a multi-species bat community. Identification of echolocation calls to species is also complicated by the short duration of bat passes, potential inaccuracy of the detector unit (Thomas and West 1984), and intraspecific variation in the minimum frequency of bat calls (Thomas and others 1987). The Skye monitor and the QMC Mini are also of limited use in detecting *P. townsendii* due to the relatively low intensity of their echolocation calls (van Zyll de Jong 1985).

Echolocation transects were conducted at 36 sites in the study area. At some sites (e.g., Yaak River Campground) bat activity was so intense that accurate counts of passes and feeding buzzes could not be made. Similar conditions often occurred for brief periods of time at other locations. Data were collected from 24 sites in the study area that were visited on two sample nights. For purposes of establishing a comparative index of bat activity for each survey location, a count was made of all passes and feeding buzzes detected for 0.5 hours following the start of audible bat activity on each night. This method of analysis eliminates blocks of non-activity that result from beginning monitoring too early in the evening from calculations. The number of passes and buzzes were multiplied by two, to express them as passes and buzzes per hour. The passes and buzzes per hour of two trials at each site were averaged to yield an overall index of bat activity for each site. At some transect locations, sampling for 0.5 hours after the start of bat activity was not accomplished for one of the two trials. Sampling at these sites was typically 2-3 minutes short of 0.5 hours. Data from these sites were included in the analysis, and contained in parentheses. Foraging percentage was calculated as the percentage of total bat passes containing a feeding buzz detected at the 24 transect locations.

Mine survey methods

Several adits were investigated for evidence of bat activity and suitability as bat habitat. Care was taken to minimize disturbance to bats that might be present (Perkins 1993). Some adits were also set with mist nets to capture any bats that might use them.

RESULTS

Species composition and relative abundance

A total of 123 bats representing eight species were captured in the study area during 1993 (Table 2). Two species - *Plecotus townsendii* and *Lasiurus cinereus* - are represented by only one capture during the study, at Flat Creek on the Superior Ranger District. *Myotis lucifugus* comprised 48 percent (n=59) of all captures. Most captures of *M. lucifugus* occurred at Lower Fortine Creek (n=35) and Sunday Creek (n=9). At the remainder of the capture sites, *M. lucifugus* comprised only 20 percent of bats captured. Bats of the genus *Myotis* were captured most frequently, comprising 91 percent (n=112) of total captures. After *M. lucifugus*, other species of the genus *Myotis* captured include *M. californicus* (15%), *M. evotis* (13%), *M. volans* (8%), and *M. ciliolabrum* (7%). *Lasionyctereris noctivigans* comprised 7 percent (n=9) of all captures, being the most common non-*Myotis* bat encountered. *Plecotus townsendii* and *Lasiurus cinereus* each comprised less than one percent of the total capture.

Relative bat abundance as expressed by bat passes per hour varied greatly between sites monitored during the study (Table 3). High levels of bat activity were found at Camp 32 (74 passes/hr.), Upper Fortine Creek (72 passes/hr.), and Trout Creek (60 passes/hr.). Sites demonstrating the most foraging activity as measured by feeding buzzes per hour were Camp 32 (n=29), Big Creek (n=14) and Bull Lake (n=13). The mean index of bat activity at the 24 transect locations was 33.5 ± 8.9 passes per hour and 6.3 ± 2.7 feeding buzzes per hour (α=0.025).

Capture success

Bats were captured at 24 of 33 locations visited during the study (73%). Attempts to capture bats were made on 54 nights, of which 33 attempts resulted in one capture or more (61%). Bats were not captured on 21 sampling nights at 18 locations (Table 4). A higher number of species were captured at Flat Creek and Bear Creek (n=4) than at other sites, although sampling effort was greater at Bear Creek. Ten sites yielded three species or more - Flat Creek (4), Bear Creek (4), Rock Creek (3), Ross Creek Cedars (3), Timberlane Campground (3), Lower Fortine Creek (3), Sylvan Lake (3), Weigle Creek (3), Big Creek (3), and Young Creek (3). Other sites yielded two species (n=7), one species (n=7), or none (n=9). See Table 2 for summary figures.

Table 2.-- Bats captured at 24 sites on the Kootenai National Forest and Lolo National Forest, 1993.

		Myotis lucifugus	*Myotis californicus*	*Myotis evotis*	*Myotis volans*	*Myotis ciliolabrum*	*Lasionycteris noctivigans*	*Lasiurus cinereus*	*Plecotus townsendii*	Total	No. of visits	allowing
	Trout Creek 69.1.82 1 mi.		1	2 87						3	2	
sec 34	Dowey Gulch 68.1.51 MINE			1	152					2	1	
sec 23	Flat Creek 69.1.83 (mi.)					1	2 85	1 86	1 57	5	2	
296	Devils Gap	1 - 297								1	2	<0.5
298	Marten Creek		1 - 299	1 - 300						2	1	5-10 m
301	Rock Creek				2 - 302	2 - 303	2 - 304			6	2	5-10 mi
305	Upper Beaver Creek		1 - 306							1	1	5-10 mi
307	Lower Beaver Creek	1 - 308					1 - 309			2	2	5-10 mi
310	Vermillion River			1 - 311						1	1	5-10 mi
312	Ross Creek Cedars	2 - 313		1 - 314	3 - 315					6	2	<0.5 mi
316	Bill Lake	1 - 317								1	1	0.5-5 mi
318	Bear Creek	1 - 319	2 - 320	2 - 321			1 - 322			6	4	0.5-5 mi
323	Timberlane C.G	2 - 324		1 - 325		4 - 326				7	3	<0.5 mi
327	Upper Fortine Creek	1 - 328					1 - 329			2	1	0.5-5 mi
330	Lower Fortine Creek	35 - 331		3 - 332			1 - 333			39	2	0.5-5 mi
334	Sunday Creek	9 - 335								9	1	0.5-5 mi
336	Five Mile Creek		2 - 337							2	2	0.5-5 mi
338	Sylvan Lake C.G.	2 - 339	2 - 340	1 - 341						5	2	<0.5 mi
342	Weigle Creek	2 - 343		1 344	1 - 345					4	1	0.5-5 mi
346	Bristow Creek		2 - 347							2	1	<0.5 mi
348	Big Creek	1 - 349	2 - 350		2 - 351					5	2	0.5-5 mi
352	Sutton Creek	1 - 353				1 - 354				2	2	0.5-5 mi
355	Camp 32		2 - 356	2 - 357						4	2	<0.5 mi
358	Young Creek		4 - 359		1 - 360		1 - 361			6	2	0.5-5 mi
	Total	59	19	16	10	8	9	1	1	123	42	

Table 3.-- Index of bat actvity for 24 transect sites on the Kootenai National Forest and Lolo National Forest, 1993. *

Transect Sites	Passes / hr.	Buzzes / hr.
Cabinet Ranger District		
Devils Gap Rd. 151	26	6
Rock Creek Rd. 150	(43)	(6)
Upper Beaver Creek Rd. 152	7	0
Lower Beaver Creek Rd. 301 - 152	16	4
Three Rivers Ranger District		
Ross Creek Cedars	4	0
Bull Lake	50	13
Clearcut by Rd. 427	1	0
Libby Ranger District		
Timberlane Campground	(57)	(4)
Bear Creek	27	1
Bear Creek Rd. 4784 - 278 - 6212	20	1
Fortine Ranger District		
Upper Fortine Creek by Rd. 48	(72)	(11)
Lower Fortine Creek Rd. 433 - 3651	19	3
Fisher River Ranger District		
Five Mile Creek Rd. 48 - 6277	52	11
Sylvan Lake Rd. 154	16	3
Rexford Ranger District		
Big Creek Rd. 336	58	14
Little North Fork Rd. 336	28	6
Sutton Creek Rd. 619	(37)	(9)
Camp 32 Rd. 7182	(74)	(29)
Young Creek Rd. 7202	38	5
Arnold's Pond Rd. 7211	44	11
Superior Ranger District		
Trout Creek Rd. 450	(60)	(1)
Slowey Gulch Rd. 389	18	5
Dry Fork Rd. 342	19	0
Flat Creek Rd. 194	19	8

* Calculated as the mean number of passes and buzzes per hour from trials on two separate nights. Data in parentheses indicates where numbers have been rounded.

Foraging activity

Bats were regularly encountered foraging over roads, creeks, and ponds in the study area (Table 5). A total of 1,031 bat passes were detected during two surveys at each of the transect sites. Of these, 196 passes contained a feeding buzz (19 percent). Foraging activity was highest at Camp 32 where 43 percent of bats encountered were attempting to capture prey. No foraging bats were encountered at three sites - Ross Creek Cedars, upper Beaver Creek along road 152, and at the clearcut by road 427.

Table 4.-- Sampling nights at sites on the Kootenai National Forest and Lolo National Forest with no bat captures, 1993.

Site	Dates	Possible Contributing Factors
Sites with successful captures on alternate nights		
Devils Gap	5/15/93	
Lower Beaver Creek	6/1/93	
Bear Creek	7/3/93	
Trout Creek	8/21/93	thunderstorm
Sylvan Lake	8/31/93	rain
Sutton Creek	9/11/93	rain and severe wind
Big Creek	9/13/93	
Flat Creek	9/26/93	
Upper Beaver Creek	9/28/93	
Sites from which no bats were captured		
Yaak River Campground	5/21/93, 9/15/93	
Callahan Creek	5/27/93	thunderstorm
Seventeen Mile Creek	5/28/93	
Little North Fork / Big Creek	5/30/93, 8/1/93	
Alexander Creek	6/8/93	net placement in dense forest
Silver Butte Creek	6/15/93	
Big Cedar Gulch / Rock Creek	7/14/93	net placement in dense forest
Dry Creek	7/18/93	
Arnold's Pond	8/2/93, 9/12/93	

Table 5.-- Foraging activity of bats at 24 sites in the Kootenai National Forest and Lolo National Forest, 1993.

Transect site	Total passes	Total buzzes	Percent foraging
Camp 32 Rd. 7182	68	29	42.6
Slowey Gulch Rd. 389	23	7	30.4
Arnold's Pond Rd. 7211	44	11	25.0
Flat Creek Rd. 194	30	7	23.3
Big Creek Rd. 336	61	14	23.0
Devils Gap Rd. 151	28	6	21.4
Sutton Creek Rd. 619	38	8	21.1
Sylvan Lake Rd. 154	16	3	18.8
Five Mile Creek Rd. 48 - 6277	65	12	18.7
Young Creek Rd. 7202	77	14	18.2
Lower Fortine Creek Rd. 433 - 3651	22	4	18.2
Bull Lake	131	21	16.0
Upper Fortine Creek by Rd. 48	70	11	15.7
Dry Fork Rd. 342	32	5	15.6
Lower Beaver Creek Rd. 301 - 152	35	5	14.3
Rock Creek Rd. 150	48	6	12.5
Trout Creek Rd. 450	69	8	11.6
Little North Fork Rd. 336	86	9	10.5
Timberlane	67	6	9.0
Bear Creek	75	6	8.0
Bear Creek Rd. 4784 - 278 - 6212	50	4	8.0
Upper Beaver Creek Rd. 152	7	0	0
Ross Creek Cedars	5	0	0
Clearcut by Rd. 427	1	0	0
Total	**1,031**	**196**	**19.0**

Mine survey results

Two adits investigated during this study receive occasional use as a night roost (Table 6). The Trout Creek adits, located on the west side of Trout Creek at approximately 3800' and 4100' elevation, were visited by *Myotis evotis* on 13 July. Two bats were observed at the lower adit, one of which was a captured female. A male *M. evotis* was captured at the upper adit. Subsequent netting on 21 August did not capture bats at these adits, although heavy rain may have affected bat activity on that night. The lower adit contained some bat guano and culled moth wings to further indicate use as a night roost.

Other adits investigated are likely not used by bats. No sign of bat guano or culled insect parts were noted, and mist-netting at the Dry Fork adit and the Bonanza adit did not capture bats. Only a cursory examination was made of the Dixie Creek adit and the Jack Waite mine shaft along the Beaver Creek drainage. The Jack Waite mine entrance is largely blocked off, and no evidence of bat use was noted around the mine structure. The Dixie Creek adit was not fully surveyed due to safety concerns. The entrance section of the adit is very wet and may be unsuitable for bats.

Table 6.-- Results of mine surveys on the Kootenai National Forest and Lolo National Forest, 1993.

Adit	Location	Complete Survey	Guano Present	Mist Nets Used	Bats Captured
Bonanza Adit	T24N R30W sec 3	✓		✓	
Canoe Gulch Adit	T30N R29W sec 7	✓			
Dry Fork Trail Adit	T17N R12E sec 27	✓			
Trout Creek Adit (upper)	T15N R12E sec 24	✓		✓	✓
Trout Creek Adit (lower)	T15N R12E sec 24	✓	✓	✓	✓
Dixie Creek Adit	T22N R32W sec 17				
Jack Waite Mine	T22N R32W sec 17				

Bat reproduction

Only three juvenile bats were captured during the study - two male *M. lucifugus* at Lower Fortine Creek on 29 August, and one female *M. volans* at Rock Creek on 27 September. Juvenile bats represented 2 percent of the total capture. Females comprised 62 of 120 adults captured in mist nets (52 percent). Lactating females were captured at several locations (Table 7), representing 7 percent of the total bats captured, and 13 percent of adult

female bats captured. Female *M. lucifugus* thought to be gravid were noted at Lower Fortine Creek and Sylvan Lake. A gravid *M. californicus* was captured at Trout Creek, and a visibly postpartum non-lactating *M. californicus* was captured at Big Creek. Over the course of the summer, 24 percent of adult female bats were classified as either lactating (n=8), gravid (n=6), or postpartum (n=1).

Table 7.-- Lactating bats captured on the Kootenai National Forest and Lolo National Forest, 1993.

Site	Species	Date captured
Ross Creek	*Myotis volans*	7/15
Upper Beaver Creek	*Myotis californicus*	7/16
Flat Creek	*Myotis ciliolabrum*	7/28
Camp 32	*Myotis evotis* (2)	7/29
Bear Creek	*Myotis evotis*	8/25
Five Mile Creek	*Myotis californicus*	8/27
Timberlane	*Myotis ciliolabrum*	9/1

DISCUSSION

Species composition and relative abundance

There are several factors that influence the data obtained from monitoring echolocation calls of bats. Detection of bat calls is dependent on the distance between bat and monitor, and the intensity of the call. Bats using higher frequency calls (e.g., *Myotis lucifugus*) that attenuate in the air more quickly than lower frequency calls (e.g., *Lasionycteris noctivigans*) are less detectable by echolocation monitors (Fenton and Bell 1981). More significantly, "whispering" bats (notably *Plectotus townsendii*), emit low-intensity echolocation calls that are difficult, if not impossible to detect amidst the background noise of creeks, insects, etc. Generally, active bats with high-intensity echolocation calls are more readily detected than other bats. Since these biases may be assumed to exert their influence fairly equally throughout the study area, their effects are negligible for the purposes of constructing an index of bat activity to determine the relative abundance of bats between areas.

A more crucial variable affecting transect data is the weather. Conditions of cold weather and rain may lessen bat activity (Fenton et al. 1983). This was often observed during the study,

as 1993 was an unusually wet year. For example, 21 passes and 7 feeding buzzes were detected in 0.5 hours at Sutton Creek on 31 July. On 11 September, only 11 passes and 1 feeding buzz were detected on the same transect, in conditions of heavy wind and periodic rain. At other sites, inclement weather occurred during both transect nights (e.g., Ross Creek Cedars), possibly influencing bat activity. Although poor weather often diminishes bat activity, bats were sometimes observed foraging in rain. *M. lucifugus*, *M. evotis*, and *M. californicus* were all captured during moderate rain shortly after sunset on 31 May. All captured bats were adult females, one of which was identifiably gravid (*M. lucifugus*). Greater nutritional needs may require gravid females to forage in less than optimal conditions. Above average precipitation in the study area during the summer may have forced bats into foraging during poor weather out of necessity.

The time of year at which sites are sampled, and the corresponding changes in bat activity due to reproductive progression and migration may potentially affect bat activity, although Thomas and West (1991) generally did not find significant temporal changes in the levels of activity in the southern Washington Cascades and Oregon Coast Range. In this study, 10 passes and 0 feeding buzzes were detected in 0.5 hours of monitoring at Rock Creek on 19 May. On 27 September, following parturition, 30 passes and 6 feeding buzzes were detected in 28 minutes under similar environmental conditions. These results could signify the activity of juvenile bats, or the movement of adult bats from maternity roosts along drainages to hibernacula. At other sites, lower levels of bat activity were obtained from sampling late in the year. Low relative bat abundance was found at both transect locations in the Beaver Creek drainage, and sites on the Superior Ranger District (Dry Fork, Slowey Gulch, and Dry Fork) after mid-September. Rock Creek provides an exception to the low levels of bat activity generally found late in the study.

Most transects were along roads and creeks, which bats likely use as flyways between roost sites and feeding areas. Roads may also be utilized as foraging habitat in upland forests (Christy and West 1993). Due to the heterogeneity of habitat types often encountered along transect routes, it is difficult to correlate levels of bat activity obtained during this study with forest characteristics (e.g., age structure or snag density) in the immediate vicinity of the transect. Since bats may be expected to limit the distance they travel to the smallest range possible in order to conserve energy (Christy and West 1993), bats detected during this study likely find roosting habitat within the drainage that they are encountered. Therefore, the index of bat activity may be more reliable as a basis for comparing relative bat abundance between different drainages in the study area.

Several transect locations were located in large blocks of homogeneous forest types, considerably removed from roads or large creeks. The transect along the Ross Creek Cedars trail is entirely contained in old growth western red cedar forest. The transect along the clearcut by road 427 is similarly contained within a uniform clearcut with seed trees evenly interspersed throughout. Other transects were relatively contained within constant habitat types, such as Bull Lake (lake edge trail in uneven-aged pine and cedar forest) and Bear Creek (mature to old-growth cedar forest along creek). As a group, the transects on the Superior Ranger District were within a drier climate, marked by a higher abundance of Douglas-fir and ponderosa pine.

The low relative bat activity found at the clearcut area by road 427 is expected, and likely not a casualty of sampling variability or poor luck. This area does not provide roosting habitat for bats. Likewise, bats that feed over water or in the forest canopy would not be expected to utilize clearcut areas. The low relative bat activity found at Ross Creek Cedars may have been influenced by poor weather, although it is more likely that the transects took place after most bats had left their roosts and moved to more suitable foraging habitat. On 15 July, numerous bats were observed feeding high over Ross Creek prior to the start of the transect. The fairly low levels of bat activity found at Slowey Gulch, Dry Fork, and Flat Creek may be indicative of true low relative bat abundance associated with the drier forest found there, or possibly be caused by sampling late in the year at each of these sites.

Reproductive success

The observed low percentage of reproductively active females (24%) and the very low proportion of juvenile bats (Genter pers. comm.) is likely due to the cold, wet spring and summer experienced throughout western Montana in 1993. Female bats must maintain homeothermy during pregnancy and lactation, while males can go torpid if climactic conditions are unfavorable for foraging. The high metabolic costs of pregnancy, combined with weather conditions that negatively influence insect abundance, can cause a reduced fecundity in bats. Pregnant females that cannot meet their energy needs must enter into torpor, causing delayed parturition, failed reproduction, or death (Racey 1982). For colonial breeders (*Myotis* spp., *Plecotus townsendii*, and *Eptesicus fuscus*), high-quality roosting habitat is especially important in unusually wet and cold years. Maternity roost sites must be of sufficient number and quality to provide bats with the thermoregulatory benefits of colonialism, and buffer against poor weather.

Sensitive species

An adult male *Plecotus townsendii* was captured across an old road along Flat Creek on 28 July. *P. townsendii* comprised less than one percent of the bats captured during the study, a finding similar to Perkins and Levesque (1989) in Oregon. Mist netting success for *P. townsendii* over water sites in Oregon and Washington has been poor (Perkins 1993). Due to the low intensity nature of echolocation calls by *P. townsendii*, detection in the field using a tunable bat monitor is difficult, if not impossible. Therefore, the two primary methods of bat investigation used during this study are poor methods for *P. townsendii*. Used on a larger scale, surveys of mines and cave-like structures hold the greatest potential for collecting information on *P. townsendii*. Surveys of potential roost sites during both winter and summer are desirable to see if mines are being used as a maternity roost or hibernaculum (Perkins 1993).

Management for bat conservation

Maintaining bat diversity on the Kootenai National Forest and Lolo National Forest requires the provision of suitable roost sites and foraging habitat. Unfortunately, the habitat requirements for some species of bats are poorly understood, and bat populations are thought to be currently declining (Christy and West 1993). The disturbance or destruction of critical hibernacula and maternity roost sites, and the loss of habitat is the major cause for declines in bat populations. In the Pacific Northwest, old-growth forest may provide important roosting habitat for bats. Thomas (1988) and Thomas and West (1991) found that bats were 2.54 to 9.75 times more abundant in old-growth Douglas-fir stands in the Washington Cascades and Oregon Coast Range than in mature or young stands. Low feeding rates combined with high levels of bat activity at dusk and dawn indicate that bats were utilizing these old-growth stands as roosting habitat, and were foraging elsewhere. The reduction of old-growth forest due to timber harvest is likely a significant impact on bat populations.

Christy and West (1993) state that "The lack of information on basic geographic distributions, habitat associations, and the population status of Pacific Northwest bat species is a major factor hindering the development of alternative forest management proceedures that might protect bat populations." Knowledge of these basic aspects of bat ecology is of the foremost importance for effective management of native bat populations. Relative abundance data and opportunistic mist-netting can provide a means of charting population trends and adding to the knowledge of species distributions. Concentrated monitoring in homogeneous forest stands of a particular age class or snag density may indicate areas important for roosting bats. It is hoped that the

data collected on bats on the Kootenai National Forest and Lolo National Forest is a suitable reference point for future studies on bats in the northwestern forests of Montana.

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